

REMARKS

Claims 1, 10, 21, 24 and 36 have been amended. Claim 20 is canceled. New claims 58-59 are added. Claims 1-7, 10-13, 16-19, 21-28, 30-42, 44-50 and 53-59 are pending in the application.

Claims 1-5 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Kilgore et al. (US Patent No. 6,200,412) in view of Qian et al. (US Patent No. 6,136,211). Claim 6 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Kilgore et al. (U.S. Patent No. 6,200,412) in view of Qian et al. (U.S. Patent No. 6,136,211) and further in view of Williams et al. (US Patent No. 5,647,953). Claims 10-13 and 16-20 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Cui et al. (US Patent No. 5,965,463) in view of Yanagida (US Patent No. 5,445,712) and further in view of Qian et al. (U.S. Patent No. 6,136,211). Claims 21-26, 28, and 30 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Kilgore et al. (U.S. Patent No. 6,200,412) in view of Qian et al. (U.S. Patent No. 6,136,211) and further in view of Saito et al. (US Patent No. 5,681,424). Claim 27 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Kilgore et al. (U.S. Patent No. 6,200,412) in view of Qian et al. (U.S. Patent No. 6,136,211) and Saito et al. (U.S. Patent No. 5,681,424) and further in view of Williams et al. (U.S. Patent No. 5,647,953). Claims 31-35 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Kilgore in view of Qian and Saito and further in view of Yanagida. Claims 36-42 and 44-46 stand rejected under 35 U.S.C. §103(a) as

being unpatentable over Cui in view of Kilgore and further in view of Saito. Claims 47-50 and 53-57 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Cui in view of Yanagida and further in view of Saito and Qian.

Claim 1 recites a gas comprises O_2 , and wherein a hydrogen component [of the gas] and O_2 are provided in a chamber during a plasma etching at a volumetric ratio of the one to the another of at least 0.1:1. The Examiner admits that Cui, Kilgore and Saito do not teach such limitation, but alleges that it is known in the art of plasma etching that an etching parameter such as etchant concentration affects the etching rate so that it would be obvious to adjust the etchant concentration by routine experimentation for optimizing the etch rate (page 12-13 of paper no. 9). However, "etch rate" is not the stated purpose for the hydrogen component and O_2 provided in a chamber during a plasma etching at a volumetric ratio of the one to the another of at least 0.1:1. In fact, "etch rate" is **not mentioned once** in Applicant's disclosure, and therefore, such a rationale for an obviousness rejection does not exist. In fact, Applicant's disclosure states the purpose for such limitation is to facilitate etching of both polymer and photoresist over the substrate (page 9 of Applicant's application), and etching rate is not discussed. In no fair or reasonable interpretation does any combination of art of record teach or suggest a gas comprises O_2 , and wherein a hydrogen component [of the gas] and O_2 are provided in a chamber during a plasma etching at a volumetric ratio of the one to the another of at least 0.1:1 as recited in claim 1. The art of record, in any combination, fails to

teach or suggest a positively recited limitation of claim 1, and therefore, claim 1 is allowable. Applicant respectfully requests allowance of claim 1 in the next Office Action.

Claims 2-5 depend from independent claim 1, and therefore, are allowable for the reasons discussed above with respect to the independent claim, as well as for their own recited features which are not shown or taught by the art of record.

Regarding claim 10, such claim recites plasma etching at subatmospheric pressure using a gas effective to etch polymer from chamber internal surfaces, the gas comprises an oxygen component forming an oxygen and carbon compound mixture, and wherein the carbon compound is provided at from about 5% to about 80% by volume of the oxygen and carbon compound mixture. Only Cui teaches a CO gas compound mixture for etching (col. 9, Ins. 20-30). However, Cui is devoid of a teaching to a volumetric relationship between the carbon and oxygen, and an electronic search of the document verifies the same. Therefore, Cui and any combination of the art of record fail to teach or suggest a carbon compound provided at from about 5% to about 80% by volume of a oxygen and carbon compound mixture as recited in claim 10. The art of record, singularly or in any combination, fails to teach or suggest a positively recited limitation of claim 10, and therefore, claim 10 is allowable.

Moreover, claim 10 recites plasma etching at subatmospheric pressure using a gas effective to etch polymer from chamber internal surfaces. The

Examiner relies on the combination of Cui, Yanagida and Qian to reject claim 10 with the Examiner correctly stating that Cui and Yanagida do not explicitly disclose plasma etching using a gas effective to etch polymer from the chamber internal surface at subatmospheric pressure, and then relies on Qian to allegedly provide such teachings (page 5 of paper no. 9). However, the motivational rationale for providing such teachings is improper, and therefore, the combination fails as an appropriate obviousness rejection.

The Examiner states it would be obvious to modify Cui and Yanagida to teach the subatmospheric pressure per Qian because Qian allegedly teaches etchant can be exhausted from the process chamber through an exhaust system capable of achieving a minimum of about 10^{-3} Torr/subatmospheric pressure (page 5 of paper no. 9). However, such a motivational rationale statement is effectively saying that since Qian teaches processing at subatmospheric pressure, it is obvious to modify Cui and Yanagida by such teachings to allegedly teach the limitation of claim 10, which is contrary to the authority of the Federal Circuit Court and MPEP. The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. MPEP §2143.01 (8th edition) *citing In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990). Although a prior art device "may be capable of being modified to run the way the apparatus is claimed, there must be a suggestion or motivation in the reference to do so". 916 F.2d at 682, 16 USPQ2d at 1432; MPEP §2143.01; See also *In re Finch*,

972 F.2d, 1260, 23 USPQ2d, 1780 (Fed. Cir. 1992). Accordingly, since the Examiner is simply stating that the prior art device of Cui and Yanagida is capable of being modified by the teachings of Qian without providing the desirability of the modification, the rationale presented by the Examiner is contrary to the above authority. For this additional reason, the obviousness rejection against claim 10 is inappropriate and should be withdrawn, and claim 10 is allowable. Applicant respectfully requests allowance of claim 10 in the next Office Action.

Claims 11-19 depend from independent claim 10, and therefore, are allowable for the reasons discussed above with respect to the independent claim, as well as for their own recited features which are not shown or taught by the art of record.

Regarding claim 21, such claim recites a second plasma etching is conducted with the receiver having a temperature which is allowed to float. Kilgore teaches ideally maintaining reaction chamber components in a moderate temperature range of 25-150°C (col. 6, lines 24-25), that is, a specific temperature that is within the stated temperature range, but Kilgore has no teachings to a temperature that is allowed to change, or float. Cui teaches a temperature range for chamber parts (abstract). Yanagida teaches specific wafer temperatures (tables throughout disclosure). Saito teaches a wafer temperature of 20°C (col. 4, lns. 40-45). However, the art of record fails to teach or suggest a second plasma etching is conducted with the receiver having a temperature

which **is allowed to float** as recited in claim 21. The art of record fails to teach or suggest a positively recited limitation of claim 21, and therefore, claim 21 is allowable.

Moreover, claim 21 stands rejected by the combination of Kilgore in view of Qian, and in view of Saito. Claim 21 recites second plasma etching at subatmospheric pressure using a gas effective to etch polymer from chamber internal surfaces and getter halogen liberated from the polymer to restrict further etching of the material on the semiconductor wafer during the second plasma etching. The Examiner correctly states that such limitation is not taught by Kilgore and Qian and relies on Saito to teach such limitation (page 8 of paper no. 9). However, the stated rationale for modifying Kilgore and Qian by the alleged teachings of Saito is improper.

The Examiner is respectfully reminded that "[i]n determining the propriety of the patent office case for obviousness in the first instance, it is necessary to ascertain whether or not the reference teachings would appear to be sufficient for one of ordinary skill in the relevant art **having the reference before him** to make the proposed substitution, combination, or other modification." MPEP §2143.01 (8th Edition), *citing In re Litner*, 458 F.2d 1013, 1016, 173 USPQ 560, 562 (CCPA 1972) (emphasis added). Although a prior art device "may be capable of being modified to run the way the apparatus is claimed, there must be a suggestion or motivation in the reference to do so". 916 F.2d at 682, 16 USPQ2d at 1432; MPEP §2143.01 (8th Edition); See also *In re Finch*, 972 F.2d,

1260, 23 USPQ2d, 1780 (Fed. Cir. 1992). The above authority clearly demonstrates that a **motivational** rationale to modify or combine references to teach the claimed invention of an applicant is imperative for a proper obviousness rejection. "Preferably the Examiner's explanation should be such that it provides that impetus necessary to cause one skilled in the art to combine the teachings of the references to make the proposed modification." *Ex Parte Levengood*, 28 USPQ2d, 1300, 1301, Footnote 2, (Bd. Pat. App. and Inter. 1993) (citations omitted).

The stated motivational rationale for modifying Kilgore and Qian with the teachings of Saito is to reduce etching time by eliminating the over-etching time as taught in Saito (page 8 of paper no. 9). However, Saito teaches that etching a polysilicon layer 62 formed over a **stepped** substrate leaves **residual polysilicon** 62a at the corner of the step, and to remove residual polysilicon 62a the polysilicon layer 62 is over-etched adding more processing time due to the additional time to perform the over-etch (col. 5, lines 1-10). Saito teaches omitting this over-etching by providing bromine radicals in subsequent post processing to react with the residual polysilicon 62a, and therefore, the processing time is reduced (col. 5, lines 1-10).

However, Kilgore and Qian do not address and are **not concerned** with polysilicon layer formed over a stepped substrate, and therefore, it is inconceivable that either reference could be **concerned** with removing a residual polysilicon 62a formed in a corner of the step. Consequently, it is inconceivable

that Kilgore and Qian could be reasonably argued to be **concerned** with eliminating an over-etching process **directed to** removing the residual polysilicon because Kilgore and Qian are devoid of any teachings to a residual polysilicon formed in the corner of the step. One skilled in the art with the concerns disclosed by the Kilgore and Qian inventions would not look to teachings in Saito for removing a residual polysilicon in the corner of a step by eliminating an over-etching process since Kilgore and Qian have no teachings to problems with a residual polysilicon. Therefore, in no fair or reasonable interpretation does the motivational rationale exist for modifying the Kilgore and Qian inventions to reduce etching time by eliminating the over-etching process as taught by Saito. For this additional reason, the obviousness rejection against claim 21 fails for a lack of the required motivational rationale to combine the art. Claim 21 is allowable.

Claims 22-35 and 58 depend from independent claim 21, and therefore, are allowable for the reasons discussed above with respect to the independent claim, as well as for their own recited features which are not shown or taught by the art of record.

For example, claim 22 recites wherein the receiver is biased during a first plasma etching and provided at ground or floating potential during the second plasma etching. Such claim limitation is rejected by the combination of Kilgore in view of Qian and further in view of Saito wherein the Examiner correctly states Kilgore (presumably including Saito) does not teach such limitation but

relies on Qian to allegedly teach such limitation at col. 7, lines 6-7 and lines 55-57 (page 8 of paper no. 9). However, the Examiner is respectfully mistaken as to such teaching of Qian. Qian teaches that a second electrode 125 serves as an electrostatic chuck 145 that generates an electrostatic charge for electrically statically holding the substrate 25 to the receiving service 140 (col. 7, lines 55-60) wherein the embedded second electrode 125 is the conductor to which a hot RF potential is applied with the other electrodes in the chamber 30 maintained at different potentials, including electrical ground or floating potentials relative to the second electrode 125 (col. 7, lines 44-50). That is, Qian teaches that the **other electrodes** in the chamber 30, **not the electrostatic chuck 145**, are the electrodes that have the ground or floating potentials. Accordingly, in no fair or reasonable interpretation does Qian, singularly or in any combination with the art of record, teach or suggest a receiver bias during a first plasma etching and provided at ground or floating potential during a second plasma as recited in claim 22. The art of record fails to teach or suggest a positively recited limitation of claim 22, and therefore, claim 22 is allowable. Applicant respectfully requests allowance of claim 22 in the next Office Action.

Claim 36 stands rejected over the combination of Cui in view of Kilgore and further in view of Saito. Such claim recites negatively biasing the wafer receiver to a range of 100 to 400 volts. Qian teaches a chuck/receiver (second electrode 125) as having a voltage supplied to maintain different potential relative a first electrode 120 without specific teachings to a voltage (col. 7, lines 8-11).

Other references only give power and frequency parameters for producing a plasma (Kilgore at col. 6, Ins. 40-50; Saito at col. 4, Ins. 37-45). No specific voltage is provided by the art of record. Accordingly, in no fair or reasonable interpretation does the art of record teach or suggest, in any combination, negatively biasing a wafer receiver to a range of 100-400 volts as recited in claim 36. An electronic search of the art of record verifies the same. Accordingly, the art of record fails to teach or suggest a positively recited limitation of claim 36, and therefore, claim 36 is allowable. Applicant respectfully requests allowance of claim 36 is the next Office Action.

Additionally, claim 36 recites a gas having one or more components effective to etch photoresist from the substrate and polymer from chamber internal surfaces and getter halogen liberated from the polymer to restrict further etching of the material on the semiconductor wafer during the second plasma etching. The Examiner correctly states Cui and Kilgore do not teach such limitation and relies on Saito with the same motivational rationale for modifying the inventions disclosed in Cui and Kilgore that was presented for claim 21 above (page 12 of paper no. 9). That is, to reduce etching time by eliminating the over-etching time as taught in Saito (page 12 of paper no. 9). However, Kilgore and Cui do not address and are **not concerned** with polysilicon layer formed over a stepped substrate, and therefore, it is inconceivable that either reference could be **concerned** with removing a residual polysilicon 62a formed in a corner of the step. Consequently, it is inconceivable that Kilgore and Cui

could be reasonably argued to be **concerned** with eliminating an over-etching process **directed to** removing the residual polysilicon because Kilgore and Cui are devoid of any teachings to a residual polysilicon formed in the corner of the step. One skilled in the art with the concerns disclosed by the Kilgore and Cui inventions would not look to teachings in Saito for removing a residual polysilicon in the corner of a step by eliminating an over-etching process since Kilgore and Cui have no teachings to problems with a residual polysilicon. Therefore, in no fair or reasonable interpretation does the motivational rationale exist for modifying the Kilgore and Cui inventions to reduce etching time by eliminating the over-etching time as taught by Saito. For this additional reason, the obviousness rejection against claim 36 fails for a lack of the required motivational rationale to combine the art. Claim 36 is allowable.

Claims 37-46 depend from independent claim 36, and therefore, are allowable for the reasons discussed above with respect to the independent claim, as well as for their own recited features which are not shown or taught by the art of record.

Claim 47 recites to providing an electrostatic chuck at ground or floating potential while second plasma etching at subatmospheric pressure. As stated in the discussion with respect to dependent claim 22, the art of record fails to teach an electrostatic chuck at ground or floating potential. Accordingly, the art of record fails to teach a positively recited limitation of claim 47, and therefore, claim 47 is allowable. Applicant respectfully requests allowance of claim 47 in

the next Office Action.

Additionally, claim 47 recites a gas effective to etch photoresist from the substrate and polymer from chamber internal surfaces and to restrict widening of the contact openings formed in the insulative oxide resulting from further etching of the material on the semiconductor wafer during the second plasma etching. The Examiner correctly states Cui and Yanagida do not teach such limitation and relies on Saito with the same motivational rationale for modifying the inventions of Cui and Yanagida that was presented for claim 21 above (page 14-15 of paper no. 9). Therefore, for the same reasoning presented above with respect to claim 21, the motivational rationale for combining Saito to modify the Cui and Yanagida inventions does not exist and must fail. For this additional reason, the obviousness rejection against claim 47 fails for a lack of the required motivational rationale to combine the art. Claim 47 is allowable.

Claims 48-53 depend from independent claim 47, and therefore, are allowable for the reasons discussed above with respect to the independent claim, as well as for their own recited features which are not shown or taught by the art of record.

Independent claim 54 recites to providing a electrostatic chuck at ground or floating potential while second plasma etching at subatmospheric pressure. As stated in the discussion with respect to dependent claim 22, the art of record fails to teach an electrostatic chuck at ground or floating potential. Since the art of record fails to teach or suggest a positively recited limitation of claim 54,

claim 54 is allowable. Applicant respectfully requests allowance of claim 54 in the next Office Action.

Additionally, claim 54 recites a gas effective to etch photoresist from the substrate and polymer from chamber internal surfaces and to restrict widening of the contact openings formed in the insulative oxide resulting from further etching of the material on the semiconductor wafer during the second plasma etching. The Examiner correctly states Cui and Yanagida do not teach such limitation and relies on Saito with the same motivational rationale for modifying the inventions of Cui and Yanagida that was presented for claim 21 above (page 14-15 of paper no. 9). Therefore, for the same reasoning presented above with respect to claim 21, the motivational rationale for combining Saito to modify the Cui and Yanagida inventions does not exist and must fail. For this additional reason, the obviousness rejection against claim 54 fails for a lack of the required motivational rationale to combine the art. Claim 54 is allowable.

Claims 55-57 depend from independent claim 54, and therefore, are allowable for the reasons discussed above with respect to the independent claim, as well as for their own recited features which are not shown or taught by the art of record.


Further, Applicant herewith submits a duplicate copy of the Information Disclosure Statement and Form PTO-1449s filed together with this application on October 2, 2000. No initialed copy of the PTO-1449s has been received back from the Examiner. To the extent that the submitted references listed on the

Form PTO-1449s have not already been considered, and the Form PTO-1449s has not been initialed with a copy being returned to Applicant, such examination and initialing are requested at this time, as well as return of a copy of the initialed Form PTO-1449s to the undersigned.

This application is now believed to be in immediate condition for allowance, and action to that end is respectfully requested. If the Examiner's next anticipated action is to be anything other than a Notice of Allowance, the undersigned respectfully requests a telephone interview prior to issuance of any such subsequent action.

Respectfully submitted,

Dated: 12-30-02

By: 
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application Serial No. 09/677,478
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Inventor Guy T. Blalock
Assignee Micron Technology, Inc.
Group Art Unit 1765
Examiner Lan Vinh
Attorney's Docket No. MI22-1544
Title: Plasma Etching Methods

**VERSION WITH MARKINGS TO SHOW CHANGES MADE ACCOMPANYING
RESPONSE TO AUGUST 28, 2002 OFFICE ACTION**

In the Claims

The claims have been amended as follows. Underlines indicate insertions
and ~~strikeouts~~ indicate deletions.

1. (Amended) A plasma etching method comprising:

etching a semiconductor wafer having a photoresist material thereon with a plasma etching material, the material forming a polymer comprising carbon and a halogen over at least some internal surfaces of a plasma etch chamber; ~~and~~

after forming the polymer, plasma etching using a gas effective to etch polymer from chamber internal surfaces and photoresist from the semiconductor wafer; the gas having a hydrogen component effective to form a gaseous hydrogen halide from halogen liberated from the polymer; and

wherein the gas comprises O_2 , and wherein the hydrogen component and O_2 are provided in the chamber during the plasma etching at a volumetric ratio of the one to the another of at least 0.1:1.

10. (Amended) A plasma etching method comprising:

etching a semiconductor wafer with a plasma etching material, the material forming a polymer comprising carbon and a halogen over at least some internal surfaces of a plasma etch chamber; ~~and~~

after forming the polymer, plasma etching at subatmospheric pressure using a gas effective to etch polymer from chamber internal surfaces; the gas comprising a carbon compound effective to getter the halogen from the etched polymer; and

wherein the gas comprises an oxygen component forming an oxygen and carbon compound mixture, and wherein the carbon compound is provided at from about 5% to about 80% by volume of the oxygen and carbon compound mixture.

Claim 20 has been canceled.

21. (Amended) A plasma etching method comprising:
positioning a semiconductor wafer on a wafer receiver within a plasma etch chamber;

first plasma etching material on the semiconductor wafer with a gas comprising carbon and a halogen, a polymer comprising carbon and the halogen forming over at least some internal surfaces of the plasma etch chamber during the first plasma etching; ~~and~~

after the first plasma etching and with the wafer on the wafer receiver, second plasma etching at subatmospheric pressure using a gas effective to etch polymer from chamber internal surfaces and getter halogen liberated from the polymer to restrict further etching of the material on the semiconductor wafer during the second plasma etching; and

wherein the second plasma etching is conducted with the receiver having a temperature which is allowed to float.

24. (Amended) The plasma etching method of claim 21 wherein the second etching is conducted ~~with a temperature of the receiver provided at from about -10°C to about 40°C and~~ at a chamber pressure of from about 30 mTorr to about 5 Torr.

36. (Amended) A plasma etching method comprising:
positioning a semiconductor wafer on a wafer receiver within a plasma etch chamber, the semiconductor wafer having a photoresist layer formed thereon;
negatively biasing the wafer receiver to a range of 100 to 400 volts;

first plasma etching material on the semiconductor wafer through openings formed in the photoresist layer with a gas comprising carbon and a halogen, a polymer comprising carbon and the halogen forming over at least some internal surfaces of the plasma etch chamber during the first plasma etching; and

after the first plasma etching and with the wafer on the wafer receiver, second plasma etching at subatmospheric pressure using a gas having one or more components effective to etch photoresist from the substrate and polymer from chamber internal surfaces and getter halogen liberated from the polymer to restrict further etching of the material on the semiconductor wafer during the second plasma etching.

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